THIS IS ONE VOLUME OF A SIX VOLUME SET WHICH INCLUDES:

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TITLE:
GROUNDWATER SAMPLING

Approved By: [signature] (Name of Approver) MAY 1 2 1992 (Date)

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) to sample groundwater from monitoring wells. All monitoring wells currently sampled on a quarterly basis and all new wells which will be installed in 1991-1992 will be sampled following these procedures.

This SOP describes equipment decontamination and transport, site preparation, detection and sampling of immiscible layers, water level measurements, well purging, sample collection, field and analytical parameters, quality assurance/quality control (QA/QC) requirements, and documentation that will be used for field data collection.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have 40-hour OSHA classroom training which meets Department of Labor regulation 29 CFR 1910.120(e)(3)(i). In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures if necessary.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

A Compendium of Superfund Field Operations Methods. EPA/540/P-87/001. 1987.

Data Quality Objectives for Remedial Activities, Development Process. EPA/540/G-87/003. 1987.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual. EPA Region IV Environmental Service Division. 1986.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document. OSWER-9950.1. September 1986.

Test Methods for Evaluating Solid Waste, SW-846. Volume II. Field Methods. Second Edition. EPA. 1982.

User's Guide to the Contract Laboratory Program. EPA. December 1988.

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows:

- SOP FO.3, General Equipment Decontamination
- SOP FO.5, Handling of Purge and Development Water
- SOP FO.7, Handling of Decontamination Water and Wash Water
- SOP FO.11, Field Communications
- SOP FO.12, Decontamination Facility Operations
- SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP FO.14, Field Data Management
- SOP GW.1, Water Level Measurements in Wells and Piezometers
- SOP GW.2, Well Development
- SOP GW.5, Field Measurement of Groundwater Field Parameters

5.0 GROUNDWATER SAMPLING PROCEDURES

5.1 INTRODUCTION

All of the alluvial monitoring wells installed on RFP property in 1986 and 1987 were constructed of either 2-inch stainless steel or 4-inch flush threaded PVC. Monitoring wells installed prior to 1986 were constructed mainly of 6-inch PVC. Limited well construction details are available for the pre-1986 wells at RFP. Bedrock wells (post-1985) completed in the weathered zone were built with 4-inch flush threaded PVC. Bedrock wells (post-1985) completed in the unweathered zone were constructed of 2-inch stainless steel or 2-inch flush threaded PVC. The screened interval of all post-1985 alluvial monitoring wells extends from approximately 0.5 foot below the alluvial/bedrock contact to a depth above the estimated highest seasonal water level. The screened interval of post-1985 bedrock monitoring wells is restricted to isolated sandstone lenses. Monitoring wells installed in 1989 were deep bedrock wells and have a 1-foot sump added to the base of the screen.

Procedures for groundwater sampling are designed to obtain a sample that is representative of the formation water beneath the site in question. Since an estimate of the quality of formation water is desired, standing water within the well must be purged before sampling. Also, a measure of the static water elevations is important to determine if horizontal and vertical flow gradients change during site characterization activities.

The groundwater sampling procedures can be initiated after taking the required water level measurements (SOP GW.1, Water Level Measurements in Wells and Piezometers) and purging the well in accordance with this SOP. Methods for accomplishing each of these activities are included in this SOP in the following sequence:

- Collection of immiscible layers samples, if present
- Well purging

- Groundwater sampling using a bailer
- Groundwater sampling using a peristaltic pump
- Groundwater sampling with a gas-powered piston pump

5.2 GENERAL EQUIPMENT REQUIREMENTS

Downhole sampling equipment will be constructed of inert material such as polytetrafluoroethylene (Teflon®) or stainless steel. This equipment will be assessed on an individual basis prior to use in the field.

The following is a primary list of well sampling and associated equipment:

- Bailers - Teflon®, stainless steel, or other appropriate inert materials
- Teflon® coated stainless steel leaders
- Peristaltic pumps
- Water level measuring devices - sufficiently accurate to measure water levels to the nearest 0.01 foot
- Plastic sheeting
- Distilled water
- Phosphate-free laboratory grade detergent
- Tap water

- Organic vapor detector (OVD)
- Gloves - latex or vinyl
- Calculator
- Containers precleaned to EPA specifications
- Coolers with sufficient blue ice to cool samples to 4°C
- Preservatives (trace metals grade)
- Disposable in-line 0.45-micrometer filters
- Logbooks and field forms
- HACH portable laboratory equipment for measuring field parameters for pH, temperature, specific conductance, dissolved oxygen, total alkalinity, and nitrate

Additional equipment needed to meet the subcontractor's health and safety standards, personnel and equipment decontamination, and any specialized sampling equipment will also be required.

5.3 EQUIPMENT DECONTAMINATION AND TRANSPORTATION

Guidelines presented in SOP FO.3, General Equipment Decontamination, will be followed for decontaminating equipment involved in groundwater sampling operations. Equipment associated with the tasks involved in groundwater sampling will be decontaminated upon arrival at RFP prior to use in the field. At a minimum, all sampling equipment will also be decontaminated between sample locations. If field conditions require more frequent decontamination, the frequency will be increased appropriately.

Transportation of all equipment will be performed in a manner that eliminates any possibility of source or cross-contamination. Calibration fluids, fuel, decontamination, and all other sources of contamination will be segregated from sampling equipment during transport. Purge water being transported to holding areas will be kept in closed containers.

If the decontamination of downhole equipment is not performed at the well, used downhole equipment will be wrapped in plastic sheeting and/or segregated from clean equipment to eliminate the possibility of cross contamination.

5.3.1 Routine Field Decontamination

Decontamination of delicate equipment and the routine decontamination of sampling equipment prior to use at each well will consist of the following steps:

- The equipment will be vigorously hand scrubbed with a solution of a phosphate-free laboratory grade detergent and distilled water.

- Rinse with copious amounts of distilled water by submerging or spraying.

- The equipment will then be triple rinsed thoroughly with approved distilled water.

- If the decontaminated equipment will not immediately be packaged to eliminate any adhesion of airborne impurities, an additional final rinse should be performed immediately prior to actual sampling operations.

5.3.2 Decontamination of Sampling Pumps

The external surfaces of all non-dedicated pumping equipment will be decontaminated as described in Subsection 5.3.1. Internal surfaces will be decontaminated as follows:

- Pump a solution of a phosphate-free laboratory grade detergent and water through the equipment.

- Displace the soap solution immediately by pumping approved distilled water; equivalent to 3 volumes of the pump storage capacity through the equipment.

- If any detergent solution remains in the pump, continue pumping distilled water through the system until the detergent is no longer visibly present. Sudsing will be the common indicator used to determine incomplete rinsing.

5.3.3 Unusual Decontamination Requirements

When equipment becomes grossly contaminated, routine decontamination of sampling equipment is not considered sufficient and thus is not allowed. This situation and other unusual equipment decontamination problems shall be reported to the field site supervisor. The field site supervisor will then consult with EG&G representatives for proper decontamination procedures.

5.3.4 Disposition of Decontamination Water

All water generated during the decontamination of equipment used in contaminated wells will be containerized for transport and discharged at the decontamination pad environmental liquids holding area. Refer to SOP FO.7, Handling of Decontamination Water and Wash Water for the criteria to identify clean and dirty environmental liquids. All decon water will be containerized.

5.4 SITE PREPARATION

Sheet plastic or vinyl sheets which may be decontaminated will be used to protect clean equipment from contacting contaminated surfaces. Plastic or vinyl wrapped around the well protective casing and staked on the ground where rope or sampling tools are placed eliminates a substantial amount of possible source contamination. Pickup tailgates, if used as a work area, may also be wrapped in plastic, or vinyl sheets, and this plastic or vinyl will be changed or decontaminated at each well. Plastic bags and sheeting along with the segregation of clean and dirty equipment will be used to reduce the chances of cross contamination significantly. If a mechanical bailer retrieval system is used the amount of plastic appropriate for protection of sampling equipment may be lessened. The site supervisor will have the responsibility for determining the amount of plastic sheeting required.

Disposable latex or vinyl gloves will be used at all times when handling sampling equipment. Gloves will be changed between each site and as often as necessary to ensure the integrity of clean sampling equipment.

5.5 COLLECTION OF IMMISCIBLE LAYER SAMPLES

When specified in the Field Sampling Plan (FSP) and/or the well to be sampled contains immiscible layers, the immiscible phases must be collected before purging activities begin. The appropriate method for detecting these layers is discussed in SOP GW.1, Water Level Measurements in Wells and Piezometers. The method of choice for collecting light phase immiscibles is a bottom valve bailer or peristaltic pump. Dense non-aqueous phase liquids (DNAPL) or "sinkers" will be collected with a bottom double check valve bailer or peristaltic pump.

In all cases, care must be taken to carefully lower the bailer into the well so that agitation of the immiscible layer is minimal. Any bailer used to collect immiscible layers will be dedicated to the well which is sampled. Peristaltic pumps will be equipped entirely with siliceous tubing when sampling immiscible layers. Dedicated equipment used for collecting immiscible layers will be decontaminated prior and after use as described in Subsection 5.3 of this SOP. Immiscible layer sampling will be performed as follows:

- Dedicated bailers will be removed from the well and decontaminated as specified in Subsection 5.3 of this SOP. Dedicated pump tubing if used will also be decontaminated prior to use.

- For light non-aqueous phase liquids (LNAPLs), the bailer intake or sampling port will be carefully lowered to the midpoint of the immiscible layer and allowed to fill while it is being held at this level. The bailer must be lowered into the immiscible layer slowly so that minimal agitation of the immiscible layer occurs. Peristaltic pump intakes will also be lowered to the midpoint of the immiscible layer.

- If a DNAPL layer is being sampled, either the double check valve bailer or peristaltic pump may be used. The bailer will be lowered into the well until bottom is encountered. Peristaltic pump intakes will also be lowered to the well bottom. Care must be taken not to submerge the pump intake into accumulated sediments.

- At no time should the bailer or line be allowed to touch the ground or come in contact with other physical objects that might introduce contaminants into the well.

- Immediately after sampling is completed, all equipment will be decontaminated. Dedicated bailers will be suspended in the well from the well cap. The bailer will be suspended above the high water level. Siliceous tubing used with peristaltic pumps will be discarded.

5.6 WELL PURGING

Purging stagnant water from a well is required so that the collected sample is representative of the formation groundwater. The device used (bailer or pump) depends upon aquifer properties, individual well construction, and data quality objectives. Wells which contain immiscible layers will not be purged. Any well scheduled for purging and sampling that subsequently has immiscible layers identified must be reported to EG&G. The EG&G project manager will be notified immediately prior to continued activities.

Before obtaining water level elevations or initiation of purge activity, obtain the following information in reference to the well to be sampled:

- Well location
- Diameter(s) of well

- Depth of well
- Screen interval(s)
- Information on environmental material disposal methods (i.e., acceptable disposal methods, sites, and receptors)

Record the well number site, date, sampling team members, visitors, well condition, and any other pertinent information on the field logsheet, or in the field logbook.

The data collected during instrument calibration will be recorded on the sample collection form or appropriate calibration log in order to document that the calibration was performed in a satisfactory manner. Instruments will be calibrated as described in SOP GW.5, Measurement of Groundwater Field Parameters.

Water level measurements will be collected as specified in SOP GW.1, Water Level Measurements in Wells and Piezometers. Measure the depth to the top of the water column and the total depth of the well in order to determine the height of the water column in the well. Calculate the well casing volume using the well casing inner diameter and the height of the water column in the well. The formula for calculating the volume in gallons of water in the well casing is as follows:

$(Q\ r^2h)\ 7.481$ = gallons; where $Q = 3.142$
r = inside radius of the well pipe in feet
h = linear feet of water in well
7.481 = gallons per cubic foot of water

- Calculations of the volume of water in typical well casings may be done as follows:

  a. 2" diameter well:

  0.16 gal./ft x ____ (linear ft of water) = gallons of water

b. 4" diameter well:

0.65 gal./ft x ____ (linear ft of water) = gallons of water

c. 6" diameter well:

1.5 gal./ft x ____ (linear ft of water) = gallons of water

5.6.1 Purging Duration

Purging will be considered complete if any of the following conditions are met:

(1) At least three casing volumes of water are removed from the well, and the last three consecutive pH, specific conductance, and temperature measurements deviate by less than 10 percent. If readings are not stabilized after three volumes, continue purging until stabilization or until five volumes have been removed. Field parameter measurements shall be collected after every half casing volume is removed from the well. When casing volumes are less that 1 liter, parameter measurements will be collected after each whole casing volume is removed. If readings do not stabilize after five well volumes, obtain additional guidance from the EG&G project manager concerning the proper course of action.

(2) A well is dewatered when the static water level requires more than thirty minutes to recover to 90 percent of its original level. For wells which are screened in a specific interval below the static water level, the criteria of 90 percent recovery in less than thirty minutes, will apply only to the screened interval plus 2 feet.

The recharge rate during recovery will be calculated linearly by determining the amount of recharge for a minimum of 10 minutes. This will be accomplished by following the procedures outlined in SOP GW.1, Water Level Measurements in Wells and Piezometers, to determine water levels. The linear feet of water in the well will then be divided either by the original saturated thickness or the screened interval plus two feet, as appropriate. This percent of recovery is then multiplied by 3 to determine the recovery rate for 30 minutes. If the value obtained is less than 90 percent of the well's original saturated thickness, prior to the start of purging, then purging will be considered complete.

Wells that dewater (have a slow recharge rate that is less than that specified in (2) above) will not be restricted by parameter stabilization requirements. Sampling of these wells will follow the protocol established in Subsection 5.8.

If a well does not dewater, and the collection method for volatile organic compound (VOC) sample collection is different from the purging method, parameters will be measured from the first water evacuated by the new method after the collection of the VOC sample. If the parameters measured are not within the tolerances allowed, as specified in Item (1) above, the previously collected VOC samples will be discarded, and purging with the new evacuation method will continue until three sets of readings are collected that indicate stabilization of the parameters within the limits specified in item (1), above. The VOC sample will then be collected again followed by the remaining sample suite.

5.6.2 Purging Methods

Wells will be purged by either bailing or pumping. When purging a well, care will be taken to ensure that the rate of water withdrawal during purging never exceeds the rate of withdrawal at which the well was developed. All purge times (initiation and completion) and the rate of purging will be recorded on the field log sheets.

5.6.2.1 <u>Bailing</u>

Generalized procedures for purging a well with a bailer are as follows:

- When purging a well with a bailer, the site will be prepared as discussed in Subsection 5.4. Properly decontaminated equipment will then be used to determine the static water level of the well. The total depth of the well will be measured. This information will be used to determine the volume of water in the well casing.

- A 5 foot leader of Teflon® coated stainless steel cable will be attached to the bailer. New rope of polypropylene or other inert material, will be securely tied to the leader. The rope length should be approximately equal to the total depth of the well. If a mechanical reel equipped with a stainless steel cable is used, attach the bailer directly to the cable. The bailer will be slowly lowered into the well until water is encountered. Agitation of the well water will be minimized. Lowering the bailer to the bottom of the well will be avoided so sediments accumulated in the bottom do not become suspended. For wells that dewater, the bailer should not be allowed to strike the well bottom with force. The bailer will be raised either by hand, ensuring that the rope or cable does not come in contact with any potentially contaminated surfaces. The bailer should be raised and lowered slowly to limit surge energy. Also, the rope or cable should not be allowed to drag along the well casing or against other objects that will cause fraying. The discharge rates and the amount of water purged will be monitored.

Wells with significant levels of contamination may have dedicated bailers installed. These wells will be selected by EG&G. Dedicated bailer systems will consist of a Teflon® bailer with check valve or double check valve for DNAPLS and a 5-foot leader of Teflon® coated stainless steel. Bailer sampling attachments and rope or stainless steel reel cable will not be dedicated to individual wells.

Prior to the initiation of purging all dedicated equipment will be decontaminated as described in Subsection 5.3 of this SOP. Dedicated equipment will be decontaminated at the conclusion of sampling activities and suspended from the well cap above the high water table. If the well interval above the high water table is not adequate to allow for storage in the casing, dedicated equipment will be stored in labeled and sealed plastic bags at the equipment trailer.

5.6.2.2 <u>Pumping</u>

Pump designs that meet the following criteria are allowed for purging:

- The pump is constructed of a material that does not introduce a source of contamination to the well.
- The pump drive system does not introduce a source of contamination into the well.
- All downhole parts to the pump can be easily decontaminated.
- A return check system that does not allow pumped water to return to the well is integral in the pump design.
- The pump is easily used and does not require excessive amounts of time to install, use, remove, and decontaminate.

A variety of pumps are currently in use to purge groundwater. These include peristaltic pumps, submersible piston pumps, and inertial pumps. Procedures for the use of each style of pump is specific to its applications. User manuals, which accompany each pump, will be referenced for operating procedures.

Basic operating procedures common to all pumps are as follows:

- Regardless of the type of pump being utilized, the site will be prepared as described in Subsection 5.4. Properly decontaminated equipment will be used to determine the static water level and total depth of the well. This information will be utilized to determine the volume of water in the well casing.

- Decontaminated pumps should be positioned at the top of the water column. As the water column is drawn down, the pump will be lowered an equivalent distance. This method eliminates the stagnation of water above the pump. For wells that historically dewater or in cases where a permanent dedicated pump has been installed, the pump may be positioned near the bottom. The discharge rates and the amount of water purged will be monitored during purging. Pumps will be decontaminated as soon as practical after use following procedures described in Subsection 5.3 of this SOP.

- Tubing, which is used for purging wells, that enters the well casing should be constructed of an inert material. Disposable silicon tubing will be used in the drive mechanism of peristaltic pumps and discarded after each well is purged. The air supply for all air driven pumps will be free of oil (i.e., no hydrocarbon containing substances will be added to the compressor).

5.7 FIELD PARAMETERS

SOP GW.5, Field Measurement of Groundwater Field Parameters, will be followed. The following field parameters will be measured during groundwater sampling:

Parameter	Relative Precision	Minimum Calibration
pH	.01 pH units	Daily
Conductivity	10 uS/cm	Daily
Temperature	.1 °C	Weekly
Dissolved Oxygen (D.O.) photometric	.1 mg/l	Each sample
Total Alkalinity unfiltered	1 mg/l	Each well
Nitrate as N photometric	.1 mg/l	Each sample
Turbidity, photometric (FTU)	2 FTU	Each sample

The measuring equipment will be stored and handled in a manner that will maintain the integrity of the equipment. Specific procedures and requirements for calibration and use of measuring equipment are given in SOP GW.5, Field Measurement of Groundwater Field Parameters. Appropriate field manuals will accompany each instrument in the field. Each instrument will also be given an identification number. All logbook and field form references to individual instruments will refer to this number for ease of identification.

Field parameters will be measured at the following intervals:

- Conductivity, pH, temperature, D.O., and turbidity will be measured prior to well purging. This initial bail of water will be carefully removed from the well. This water will be transferred to a sample beaker by decanting the bailer through a bottom control valve. Wells purged with a pump will similarly have the first water removed, and measured for parameters. D.O. will be measured first to limit the sample's exposure time to the atmosphere. Conductivity, pH, and temperature will then be measured.

- During purging operations, conductivity, pH, and temperature will be measured after every half casing volume* of water is removed from the well. Wells that have half volumes less than the volume of a sample bailer will only be measured after every full casing volume of water is removed from the well. D.O. and turbidity will be measured at least once during well purging at the discretion of the sampling crew.

- During purging, if a well is dewatered prior to the measurement of the final required set of parameters, then conductivity, pH, temperature, and turbidity will be measured immediately before the start of sample collection. These parameters may be delayed until sampling is completed if, at the discretion of the sampling crew, the well recharge has provided insufficient water volume to collect all the samples and also measure parameters.

- The final D.O. will be measured immediately following volatile sample collection. Water remaining in the bailer after the filling of VOC vials will be transferred to a beaker using the bottom decanting valve. A determined effort will be made to limit this water from agitation and exposure to the atmosphere. If there is insufficient water in the bailer to perform this test, water decanted from the next bailer of water will be used to measure D.O. prior to any sample collection. This parameter may be delayed until sampling is completed if, at the discretion of the

* A half-volume is defined as the volume of one-half the initial well casing water volume, which will be calculated as specified in Subsection 5.6.

sampling crew, the well recharge has provided insufficient water volume to collect all the samples and also measure parameters.

- Whenever a method used to remove well water is changed, a set of field parameters will be recorded from water removed with the new method.

- Nitrate will be measured from purge water generated at wells in the vicinity of the West Spray Field. The water tested will come from the first purge volume.

- Total alkalinity measurements will be collected only once upon completion of purging. For wells that do not dewater and sample collection proceeds to completion immediately after purging, alkalinity will be measured after the completion of all other final purge field parameters. Wells that dewater and require repeated visits for the collection of samples will have alkalinity measured subsequent to the collection of the sample for inorganic water chemistry. Alkalinity will not be measured if sufficient water is not available.

5.8 GROUNDWATER SAMPLING

Techniques used to withdraw groundwater samples from a well will be based on consideration of the parameters of interest. The order of collection, collection techniques, choice of sample containers, preservatives, and equipment are all critical to ensure that samples are not altered or contaminated. The preferred methods for collection of groundwater samples are either bailing and/or the use of bladder pumps.

5.8.1 Sample Collection

The following discussion involves collection of groundwater samples using bailers, and peristaltic or bladder pumps. Regardless of the collection method, care will be taken not to alter the chemical nature of the sample during the collection activity by agitating the sample or allowing prolonged contact with the atmosphere. In order to assist in minimizing the potential for altering the sample and maximizing the available water, the following sample collection sequence is preferred:

- Radiation Screening
- HSL VOC
- BNA
- Pesticides/PCB
- TDS, CL, F, SO_4, CO_3, HCO_3
- Nitrate/Nitrite, as N
- TSS
- Gross alpha and beta
- $^{233/234}U$, ^{235}U, ^{238}U
- Dissolved Metals - TAL, with Cs, Li, Sr, Sn, Mo, Si
- Total Metals - TAL, with Cs, Li, Sr, Sn, MO, Si
- $^{239/240}$ Plutonium, ^{241} Americium
- Tritium
- ^{89}/Strontium
- ^{226,228}Radium
- ^{137}Cesium
- Cyanide
- Orthophosphate

Upon completion of purging, VOC samples will be collected first. Sampling should be done as soon as possible after the well has been evacuated. If VOCs are to be collected by a method other than that used for purging (i.e., displacement or peristaltic pump), then all other samples will be collected prior to removing the pump from the well.

For wells that dewater, the well will be allowed to recover 50 percent of its original volume before the start of sampling. If a well will not recover 50 percent within 24 hours after dewatering, the VOC sample will be collected when a sufficient volume of water has accumulated for VOC sample collection. The calculation for recovery will be performed as described in Subsection 5.6.1. However, 50 percent recovery will be used instead of 90 percent. If a sufficient volume of water for VOC sample collection has still not accumulated within 24 hours after the completion of purging, VOCs will not be collected for that well.

The containers used for sample collection from poor producing wells may differ from those used for high yield wells in some instances due to constraints on obtaining enough sample to fill sample containers. In some instances smaller containers may be utilized, or chemical parameters normally collected in separate containers may be combined into a single container. Well histories can be used to identify which wells may require the modified sample suite. These wells will be sampled for a maximum of 32 hours after the completion of purging, with the exception of VOC sample collection discussed in the previous paragraph. The completion of purging will be considered 0 hour. At the end of 32 hours, partial samples will be measured. If a well is purged in the a.m. on day one, then the well can be sampled anytime the next day. Accumulated sample will be compared to the minimum volume requirements identified in Table GW.6-1. If the minimum volume requirement for the target parameter has not been achieved, the partial sample and bottle will be disposed. This volume may be less than the typical volume collected. All parameters which have only minimum samples volumes collected and all uncollected parameters will be documented.

The order of the parameters in this sample hierarchy may be changed at the discretion of the sampling team. Changes in the hierarchy will be based on the predicted number of parameters that will be collected. The sampling team must document their calculations that will substantiate any change in the sample order prior to deviation from this plan.

Sample containers will be stored away from sunlight and will be cooled to 4°C prior to filling. Immediately after collection, samples requiring cooling will be cooled to 4°C. A chilled cooler will be used as the storage container. Whenever a sample bottle which requires chilling is not being physically handled, it will be placed in the cooler to prevent heating or freezing, exposure to sunlight, and possible breakage.

TABLE GW.6-1
SAMPLE CONTAINERS AND PRESERVATIVES
FOR GROUNDWATER SAMPLES

PARAMETER	MINIMUM CONTAINER[1]	PRESERVATIVE
Radiation Screen	6 oz poly	None
VOC - CLP	2 - 40ml amber glass	Cool to 4°C
BNA	1 L amber glass	Cool to 4°C
Pesticides/PCB	1 L amber glass	Cool to 4°C
TSS	125 ml poly	
TDS, Cl, F, SO_4, CO_3, HCO_3	1 L poly	Cool to 4°C
Metals - CLP, with Cs, Li, Sr, Sn, Mo, Si	1 L poly	Filtered, HNO_3 to pH <2, Cool to 4°C
TOC	125 ml poly	H_2SO_4 < pH2 Cool to 4°C
COD	125 ml poly	H_2SO_4 < pH2 Cool to 4°C
Metals - CLP with Cs, Li, Sr, Sn, Mo, Si	1 L poly	Unfiltered, HNO_3 to pH <2, Cool to 4°
Orthophosphate	250 ml poly	Filtered, Cool to 4° C
Nitrate / Nitrite as N	250 ml poly	H_2SO_4 to pH <2, Cool to 4°C
Cyanide	1 L poly	Na OH to pH >12, Cool to 4°C
Gross Alpha / Beta	550 ml poly	HNO_3 to pH <2
$^{233/234}U$, ^{235}U, ^{238}U	100 ml poly	Filtered, HNO_3 to pH <2
$^{239/240}Pu$	1 L poly	HNO_3 to pH <2
^{241}Am	1 L poly	HNO_3 to pH <2
$^{89/90}Sr$	700 ml poly	Filtered, HNO_3 to pH <2
$^{226/228}Ra$	750 ml poly	Filtered, HNO_3 to pH <2
^{137}Cs	2.5 L poly	Filtered, HNO_3 to pH <2
^{3}H	100 ml glass	

1 The volume listed is the minimum amount required for analysis. Actual sample volumes may be slightly higher and some parameters may be combined in a single container.

VOC samples will be collected using a bailer equipped with a bottom-decanting control valve. Vials will be filled by dispensing water through the control valve and along the inside edge of the slightly tilted sample vial. Care will be taken to eliminate aeration of the sample water. The vials will be filled beyond capacity so the resulting meniscus will produce an airtight seal when capped. The capped vial will be checked for trapped air by lightly tapping the vial in an inverted position. If air becomes trapped in the vial, the sample water will be discarded, and the vial will be refilled. If two consecutive attempts to fill a VOC vial result in trapped air bubbles, the vial will be discarded.

VOC vials will never be filled and stored below capacity because of insufficient quantities of water in the bailer. Except for the VOC vials, adequate air space should be left in the bottle to allow for expansion.

Sites will be prepared prior to sampling as described in Subsection 5.4. All necessary and appropriate information will be recorded on the appropriate field forms or in the logbook.

Samples will be placed in the appropriate containers and packed with ice in coolers as soon as practical. Packaging, labeling, and preparation for shipment will follow procedures as specified in SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. When sampling is complete, the well cap will be replaced and locked.

Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use as specified in Subsection 5.3. Liquids and materials from decontamination operations will be handled in accordance with SOP FO.5, Handling of Purge and Development Water. Sample containers will also be protected from sources of contamination. Sampling personnel will wear chemical-resistant gloves when handling samples. Gloves will be decontaminated or disposed of between well sites.

5.8.1.1 Groundwater Sampling Using a Bailer

This portion of SOP GW.6 describes the use of a bailer for collecting groundwater samples that may be used to obtain physical, chemical, or radiological samples.

A bailer is carefully lowered into the well by means of a new polypropylene rope or other line made of inert material. After filling within the well, the bailer is withdrawn by retrieving the bailer line, and the bailer contents are drained into the appropriate containers. Certain recommendations and/or constraints should be observed when using bailers for sampling groundwater quality monitoring wells:

- Only bottom-filling Teflon® bailers or bailers made of other inert materials will be used.
- Only unused, decontaminated, or dedicated bailer line will be used. A 5-foot leader of Teflon® coated stainless steel cable will be attached to the bailer.
- A reel upon which the bailer line may be wound is helpful in lowering and raising the bailer. It also reduces the chance of contamination.
- Bailers constructed with adhesive joints will not be used.

Lower the bailer slowly to the interval from which the sample is to be collected. A determined effort will be taken to minimize disturbance of the water column when raising and lowering the bailer in order to prevent aeration of the water column. For VOCs, sample bottles will be filled by allowing the water to flow out the valve in the bottom of the bailer and into and along the side of the sample bottle. The remainder of the sampling water will be collected in a stainless steel container. Sample containers will then be filled from the water in the stainless steel container. Samples requiring filtration will be filtered and then containerized.

5.8.1.2 Groundwater Sampling Using a Peristaltic Pump

Use of peristaltic pumps will be limited to collecting sample aliquots for radionuclides, metals, and other species that are not subject to volatilization and degassing. Peristaltic pumps will never be used to collect volatile organics or other volatile species. All downhole tubing will be composed of Teflon®. Only the portion of tubing which is inserted into the mechanical drive will be made of silica. This drive portion of the tubing will be discarded after each use.

5.8.1.3 Groundwater Sampling Using a ©Bennett Gas-Powered Piston Submersible Pump

The gas-powered piston submersible pump is a portable system for purging wells with water depths up to 250 feet. The system is operated by compressed gas (air or nitrogen) and driven by an air motor. The pump is self-priming, and the gas that drives the pump does not contact the purged water. The pump is constructed from stainless steel and can be decontaminated easily.

The feasibility of using this pump for well purging and sampling will be the responsibility of the site supervisor. The following criteria will be considered when using this pump:

- The compressor used to power the pump will be located a minimum of 15 feet downwind from the well to eliminate the contamination of equipment with exhaust.

- If the seal located between the motor and the pump is bridged, air will exit through the discharge line. If this problem occurs, pump operations will be stopped and the seals replaced. If the shaft is worn and a proper seal cannot be maintained, the shaft will be replaced.

- Upon completion of purging, the pump will be allowed to continue pumping at a rate no less than .5 liters per minute. Allowing the pump to stop will cause the water trapped in the discharge lines to equilibrate to ambient temperatures. This is not acceptable. During sampling, the pump can be slowed to any rate which allows efficient sampling.

- After completion of sample collection, the pump must be removed to allow for VOC sample collection with a bailer. While retrieving the pump, water used to rinse the lines will not be allowed to trickle into the well.

5.8.2 Sample Filtering and Preservation

Samples for dissolved metals, Gross Alpha/Beta, $^{233/234}$Uranium, ^{235}Uranium, ^{238}Uranium, $^{89/90}$Strontium, ^{137}Cesium, ^{226}Radium, ^{228}Radium, and orthophosphate will be filtered in the field at the well location during the sampling event through a disposable 0.45-micrometer membrane filter. If a peristaltic or bladder pump is being utilized, a disposable filter may be attached directly to the sample delivery line so that the sample is filtered directly into the sample container as it exits the delivery line. Discharge pressure will be gauged so it does not exceed 50 psi. Alternatively, sample water may be collected in a stainless steel container and filtered with a peristaltic or vacuum pump. Samples to be analyzed for volatile organic species will not be filtered. Before sample collection, 100 to 200 milliliters of sample water will be passed through the filter in order to rinse the filter and filtration apparatus of possible contaminating substances.

Samples requiring filtration will be filtered prior to addition of preservative chemicals. Preservatives will be added to sample bottles prior to the introduction of sample water. The preservative will be added in multiple 5 ml aliquots appropriate to the size of the bottle. One-liter bottles will have 5 ml of sample added prior to sample collection, while 4-liter bottles may have up to 20 ml of acid added. After sample collection has been completed the pH of preserved samples will be checked as follows:

- A small amount of sample will be poured from the sample bottle directly onto approved pH paper. Care will be used so that the threaded neck of the bottle does not contact the pH paper.

- The Ph paper will be checked against the supplied color chart. If the appropriate Ph has not been achieved, additional preservative will be added to the sample in 5ml aliquots, and the Ph test will be repeated.

5.8.3 Sample Screening

A sample for radiation screening will be collected for each well sampled, as specified in Subsection 5.8.1. This sample may be obtained from static well water up to 3 days before the sampling event. If the radiation screen is being collected during the sampling event, it may be obtained from the purge water prior to completion of purging. This sample will be delivered to the EG&G or subcontracted radiation screening laboratory on the day after collection. The sample will be screened for gross alpha, and samples from the corresponding well will be handled according to the levels of radioactivity detected in the sample, as specified in SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

5.8.4 QA/QC Samples

The frequency and types of field QA/QC samples collected during groundwater sampling are described in the Environmental Restoration Quality Assurance Program Plan. This SOP details the applicable criteria for collecting QA/QC samples.

5.8.4.1 Duplicates

Duplicate samples will be collected only from wells that produce enough water to collect two full suites of analytes without dewatering. The wells which produce sufficient water will be incorporated into the sampling program such that the required duplicate frequency can be maintained.

Wells scheduled for duplicate sample collection will be sampled as described in Subsection 5.8 of this SOP. After collection of a complete suite of samples, all downhole equipment will not be decontaminated. Duplicate collection will be performed using the same equipment used for the original sample collection. The duplicate sample suite will be collected in the same order as the original sample suite beginning with VOCs. Additional field parameters will not be measured during duplicate sample collection.

When a pump is being used for sample collection, all samples collected through the pump will be collected first. VOCs, collected using a bailer, will follow. After collection of the original VOC sample, the bailer will be emptied. The bailer will then be lowered into the well and allowed to fill a second time. Water from the second filling will be used for the duplicate VOC sample.

If a well is being used for matrix spike (MS) and matrix spike duplicate (MSD) samples the duplicate will be collected after collection of the MS and MSD.

All duplicate samples will be given a sample number different from the original sample.

5.8.4.2 Matrix Spike and Matrix Spike Duplicate

MS and MSD samples will be collected only from wells that produce enough water to collect the required suites of analytes without dewatering. The site supervisor will assign MS and MSD samples to reflect the different groundwater matrices established by EG&G.

MS and MSD samples will be collected as follows:

- The well will be purged as described in Subsection 5.6 of this SOP.

- After completion of purging, VOC samples will be collected. The original sample will be collected followed by the MS and MSD. These samples will be collected in immediate succession. All D.O. parameter measurements will be taken after filling the last VOC vial.

- The remaining parameters not requiring filtering will be collected. For each sample parameter, the original sample, MS, and MSD will be collected concurrently. The original sample bottle will be filled one-third full followed by the MS and MSD sample bottles which will also be filled one-third full. Each bottle will be rotated in the sequence, filling in one-third full until all three bottles are full. For analytes not requiring a MSD, only the original sample and the MS will be collected.

- After the original sample, MS, and MSD (where appropriate) are collected for one parameter, the process will be repeated for the next parameter.

- Parameters requiring filtering will be collected similarly. When a bailer is used, a stainless steel bucket will be filled with sample water. As samples are collected and the reservoir of water in the bucket is depleted, additional water may be added at the discretion of the sample crew. When a pump is used, the filter will be attached directly to the discharge line. Sample bottles will be filled as described above, partially filling the original sample, MS, and MSD in rotating sequence until each parameter bottle is full.

- Radiochemistry samples may have more than one bottle for each parameter group. In this case, all required bottles will be included in the rotating sequence.

- Field Parameter measurements will not be required for MS and MSD samples.

MS and MSD samples will retain the original sample number. However, a suffix of MS or MSD will be added to the sample number to correspond with each QA/QC sample.

5.8.4.3 Replicates and Splits

Replicate and split samples will be collected in the same manner as described for the MS and MSD. Replicates and splits exceeding three samples will be referred to EG&G for further instructions.

5.8.4.4 Field Equipment Rinses

Field equipment rinses will be collected in a manner designed to reflect sampling techniques. All equipment used during sampling will be rinsed with distilled water. The resulting rinsate will be collected in bottles identical to those used for the original sample.

5.8.4.4.1 Bailed Wells. After completion of sampling, all equipment will be decontaminated. Prior to leaving the well location, the equipment rinse will then be collected as follows:

- The bailer will be filled with distilled water by pouring the water into the top opening. When polypropylene rope is used, the water should be allowed to rinse a short section of clean rope while filling the bailer.

- The rinse water should then be decanted to the VOC vials through the bottom valve. This will be done in the same manner used during sample collection.

- For the remaining unfiltered parameters, the bailer will be filled with distilled water each time additional rinsate is needed. The rinsate will then be transferred to sample bottles in the same manner used during collection.

- Filtered parameters will also be collected in an identical manner to the original samples. The bailer will be filled with distilled water. The rinse water will then be transferred to a stainless steel bucket. The rinse water in the bucket will then be filtered through a new disposable filter.

- Rinse samples will be preserved to the same Ph levels as original samples.

5.8.4.4.2 Pumped Wells. Only sampling equipment used during the pumping of wells will be included in the field equipment rinse. VOC rinse samples will be collected using a bailer as described in Subsection 5.8.4.4.1. Distilled water will be pumped from a stainless steel bucket when simulating sampling conditions for all other parameters. These samples will be collected as follows:

- While filling the bucket, distilled water will be poured over the lower section of pump power and discharge lines.

- The volume of stored water in the pump lines will be purged at least once with the rinse water before sample collection.

- Sample bottles will be filled directly from the pump discharge line, simulating actual sampling techniques. Filtered rinsate will be passed through a disposable filter attached directly to the discharge line.

5.8.4.5 Distilled Water Blanks

Distilled water used for the final decontamination of equipment will be transferred directly to sample bottles to determine any baseline contamination they may have introduced into the samples. Five gallon bottles of water will be opened in a controlled area such as the bottle storage room. Distilled water will then be poured directly from the 5-gallon bottle into the appropriate sample bottle. A Teflon®, glass, or stainless steel funnel may be used to help control flows into small mouth bottles. Blank samples will be preserved to the appropriate Ph required for each analyte.

5.9 SAMPLE HANDLING AND CONTROL

Pre-cleaned sample containers will be obtained from the contract analytical laboratory. Preserving solution will be added to the bottles by either the laboratory, the sample manager at the sample trailer, or preferably, the sample technician in the field. If preserving solution is added by the sample manager, the sample manager will also label the bottles to indicate the type of sample to be taken.

The sampling containers, preservation requirements, and holding times for the various types of analyses are shown in Table GW.6-1. Additional information on containerizing, preserving, and handling of the water samples is given in SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Groundwater samples will be properly labelled so that they can be easily identified. The sample numbering system has been assigned by EG&G. Sample identification (ID) numbers will be assigned to each physical sample. The sample ID number will contain the following information as part of a nine to twelve character, alpha-numeric code:

Character(s)	Description	Code
1 and 2	Project ID	GW
3 through 7	Sample Number	00001 to 99999
8 and 9	Subcontractor ID	Alpha (e.g. IT = International Technology Corp.)
10, 11, and 12	QA/QC	MS for matrix spike, MSD for matrix spike duplicate

Sample numbers will be assigned on a daily basis by the subcontractor's sample manager. Numbers will be assigned consecutively, beginning with 00001. Assignment of sample numbers will be tracked and maintained on the subcontractor's computer at the subcontractor's base office.

6.0 DOCUMENTATION

All field activities will be recorded on Form GW.6A, Field Activity Daily Log, Form GW.6B, Groundwater Sample Collection Log, and Form GW.6C, Well Status Form. Summary information of the days activities or needed information not recorded on the field forms should be recorded in a bound field logbook. Logbooks and field forms will be assigned to field personnel and will remain in their custody during all sampling activities. The cover of each logbook will contain the following information at a minimum:

- Name of the organization to which the book is assigned
- Book number
- Project name
- Start and end dates

Logbook pages will be sequentially numbered before any data recording. All data and information pertinent to field sampling will be recorded in the logbook or on the field forms that identify all required data entries. Enough detail must be included in the documentation to reconstruct the sampling event. Field form entries will include the following minimum information:

- Date and time
- Names of field personnel
- Names of all visitors
- Location of field activities
- Description of sampling sites including weather conditions
- All field observations and comments
- Field parameters
- Sample identification information
- References to all prepared field activity forms and chain-of-custody records

Field logbooks will normally be kept only by the field sampling team leaders and the site supervisor and will be used only to summarize field activities and to document project information not required by the SOP field forms.

Permanent ink will be used for all entries in the logbooks and on the field forms. Mistakes will be crossed out with a single line, initialed, and dated. Unused pages or partial pages will be voided by drawing a line through the blank sections and initialling. Any deviation from this SOP will require documentation in the site supervisor's logbook.

The field activity daily log narrative should create a chronological record of the media team's activities, including the time and location of each activity. Any descriptions of problems encountered, personnel contacted, deviations from the SOP, and visitors on site should also be included. The weather conditions, date, signature of the person responsible for entries, and the number of field activity daily log sheets used to record media team activities for a given day will also be included.

The Groundwater Levels Measurement/Calculations Form (see SOP GW.1, Water Level Measurements in Wells and Piezometers) and the Chain of Custody Record (see SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples) will also be completed for each site. All blank fields on the forms must be completed or voided.

Daily Log	Date:
	Sheet of

Field Activity Daily Log

ROCKY FLATS PROJECT: Ground Water Sampling Program	PROJECT NO.:
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS
WEATHER CONDITIONS: (precip.,temp.,clouds)	IMPORTANT PHONE CALLS
SAMPLING TEAM PERSONNEL:	
SIGNATURE OF PREPARER:	DATE:

U.S. DEPARTMENT OF ENERGY

ROCKY FLATS PLANT
GROUND WATER SAMPLE COLLECTION LOG

Project Name: Quarterly Ground Water Sampling
Project No.: 304902 . ___ ___ . ___ ___ . ___ ___
COC/RFA/ No.: ____________________
COC/RFA No.: ____________________
QC Review By/Date: ____________________

Sample No.: GW ___ ___ ___ ___ ___ IT
Well I.D. ____________________
Samples Collected By: ____________________
Zone: __________ __________
Dates Collected: ____________________

PURGE METHOD - TYPE USED:

☐ PUMP ☐ PERISTALTIC ☐ OTHER ____________________

☐ BAILER ☐ TEFLON ☐ OTHER ____________________

PURGING REQUIREMENTS & CALCULATIONS - Datum: Top of Well Casing (TOWC) PURGE DATE: __________

ID = Well Casing Inside Diameter (inches) = __________

UV = Unit Casing Volume (gal/linear foot) = __________

WD = Depth to Water (feet) = __________

TD = Total Depth (feet) = Measured Total Depth (MTD)+Probe End __________

IC = Initial Water Column (feet) = TD - WD = __________ - __________ = __________

IV = Initial Water Volume (gallons) = UV x IC = __________ x __________ = __________

SD = Depth to Top of Screen = __________ - 2ft = __________

Is WD less than SD - 2ft? (Y/N) __________ If Y, then:

AC = Adjusted Water Column(ft) = TD-SD = __________ - __________ = __________

AV = Adjusted Casing Volume(gal) = UVxAC = __________ x __________ = __________

If No, then 3 x IV = 3 x __________ = __________

Checked by: ____________________

PURGED VOLUMES and RECHARGE

Volume Purged (GAL)	Temp (°C)	Conductance (mS/cm)	pH (SU)	DO (mg/L)	Nitrate (ppm)	Time (24-hour)	Turbidity (FTU)	Water Description (Color, Turbidity, Odor, Oil, etc.)

PURGE VOLUMES & RECHARGE

Actual purged volume (gallons) = __________ Purged dry? (Y/N) = __________

90% of IC = 0.9 x IC(or AC) = 0.9x __________ = __________

10 minute Water Level Recovery: Time Start __________ Time Stop __________

ER = Estimated 30 minute recharge = (TD-10 minute WD)x3=(__________ - __________)x3= __________

Depth to water prior to sampling __________ Time __________ Date __________

Depth to water prior to sampling __________ Time __________ Date __________

Depth to water prior to sampling __________ Time __________ Date __________

Checked by: ____________________

ROCKY FLATS PLANT
GROUND WATER SAMPLE COLLECTION LOG (cont'd)

Project No.: 304902 . ____ . ____ . ____ Sample No.: GW ___ ___ ___ ___ ___ IT

Well I.D.: ______________

EQUIPMENT CALIBRATION

Equipment Type	Equipment ID #	Standard Used	Equipment Reading	Temp	Date	Time

SAMPLING METHOD - TYPE USED:

☐ PUMP ☐ PERISTALTIC

☐ BAILER ☐ TEFLON

☐ OTHER ______________

UNFILTERED - Offscale ?

☐ Yes Total Alkalinity: ________ x 10 ________ ppm at ________ pH

☐ No Total Alkalinity(Full Range) ________ ppm at ________ pH

SAMPLE PARAMETER MEASUREMENTS

TEMP (°C)	pH (SU)	CONDUCTIVITY (mS/cm)	DO (mg/L)	DATE	TIME	TURBIDITY	INITIALS

SEQUENCE OF SAMPLE COLLECTION

Analysis	Partial Recharge	RAD	VOA	α,β,U	α,β,U Cs/Ra/Sr	IN-ORG.	NITRATE	METALS	Pu Am	TRIT	Pu	Am	Cs/Ra/Sr	CYANIDE	ORTHO-PHOS-PHATE
Volume		100 ml	(2) 40ml	1 Liter	Gal	1 Liter	250 ml	1 Liter	Gal	100 ml	Gal	Gal	Gal	1 Liter	250 ml
Pres.			-	HNO_3	HNO_3		H_2SO_4	HNO_3	HNO_3		HNO_3	HNO_3	HNO_3	NaOH	
				Filter	Filter			Filter					Filter		Filter
Date															
Time															
No. of Bottles															

Comments: ______________

____

____

____

Print Name: ______________

Signature: ______________

Casing Size (inches) (a)	1	2	3	4	6
Unit Casing Volume (Gal/Lin Ft) (b)	0.04	0.16	0.37	0.65	1.50

U.S. DEPARTMENT OF ENERGY

WELL STATUS FORM

Form GW.6C
Revision 1

TEAM NO.: ______________________
TEAM MEMBERS: ______________________
ZONE: ______________________
DATE: ______________________

ROCKY FLATS PLANT

PARTIAL / FULL	WELL NO.	PURGE	RAD SCREEN	VOA (2)	α,β,U	α,β Cs,Sr,Ra	INORG.	NIT.	MET.	PU/AM	TRIT	PU/AM	Cs,Sr,Ra	CYANIDE	O PHOS
VOLUME			100 ML	40 ML	LIT	GAL	LIT	250 ML	LIT	GAL	100 ML	2 GAL	GAL	LIT	250 ML
FILTER					YES	YES			YES				YES		YES
PRES.					HNO_3	HNO_3		H_2SO_4	HNO_3	HNO_3		HNO_3	HNO_3	NaOH	